

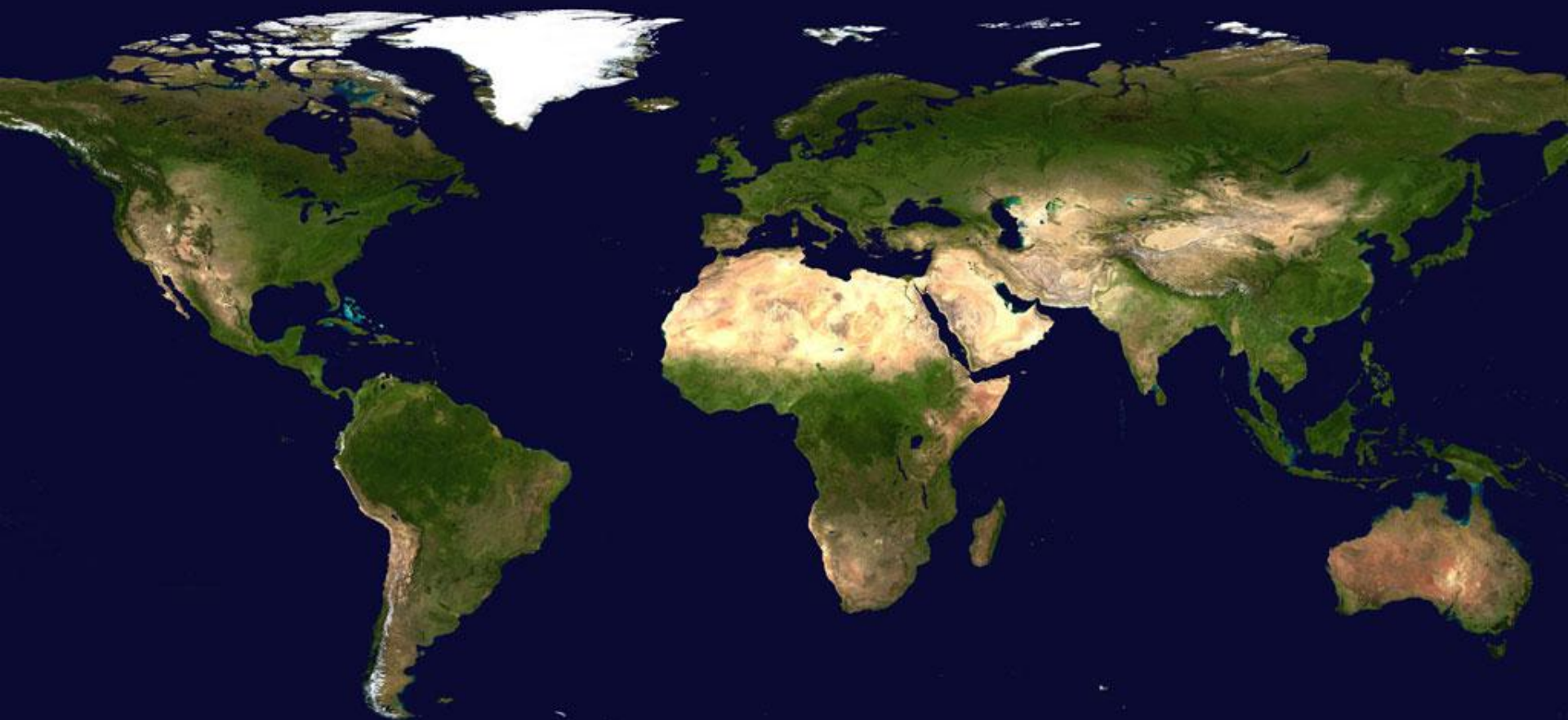
Asian Carp: Perspectives from Both Sides of the Planet

Mississippi River Forum, May 18, 2012

Brian S. Ickes (bickes@usgs.gov)

U.S. Geological Survey (Upper Mississippi River Restoration - Environmental Management Program, U.S. Army Corps of Engineers:
<http://www.umesc.usgs.gov/ltrmp.html>)

The Nature Conservancy (Great Rivers Partnership: <http://www.nature.org/ourinitiatives/habitats/riverslakes/howwework/the-partnership.xml>)



Acknowledgment

Great Rivers Partnership



The Great Rivers Partnership (GRP) is a global effort to advance sustainable management of the world's great rivers for people and nature. The GRP focuses on entire river systems and brings together the best available science and diverse stakeholders—spanning sectors from industry and navigation to academia and government—to develop and implement innovative solutions to issues threatening freshwater sustainability.

<http://www.nature.org/ourinitiatives/habitats/riverslakes/howwework/the-partnership.xml>
<http://www.youtube.com/watch?v=iyGRoUJRIrQ>

Two Great Rivers

YANGTZE

1,808,500 km²

5,980 km

34,000 m³/s

Area

Length

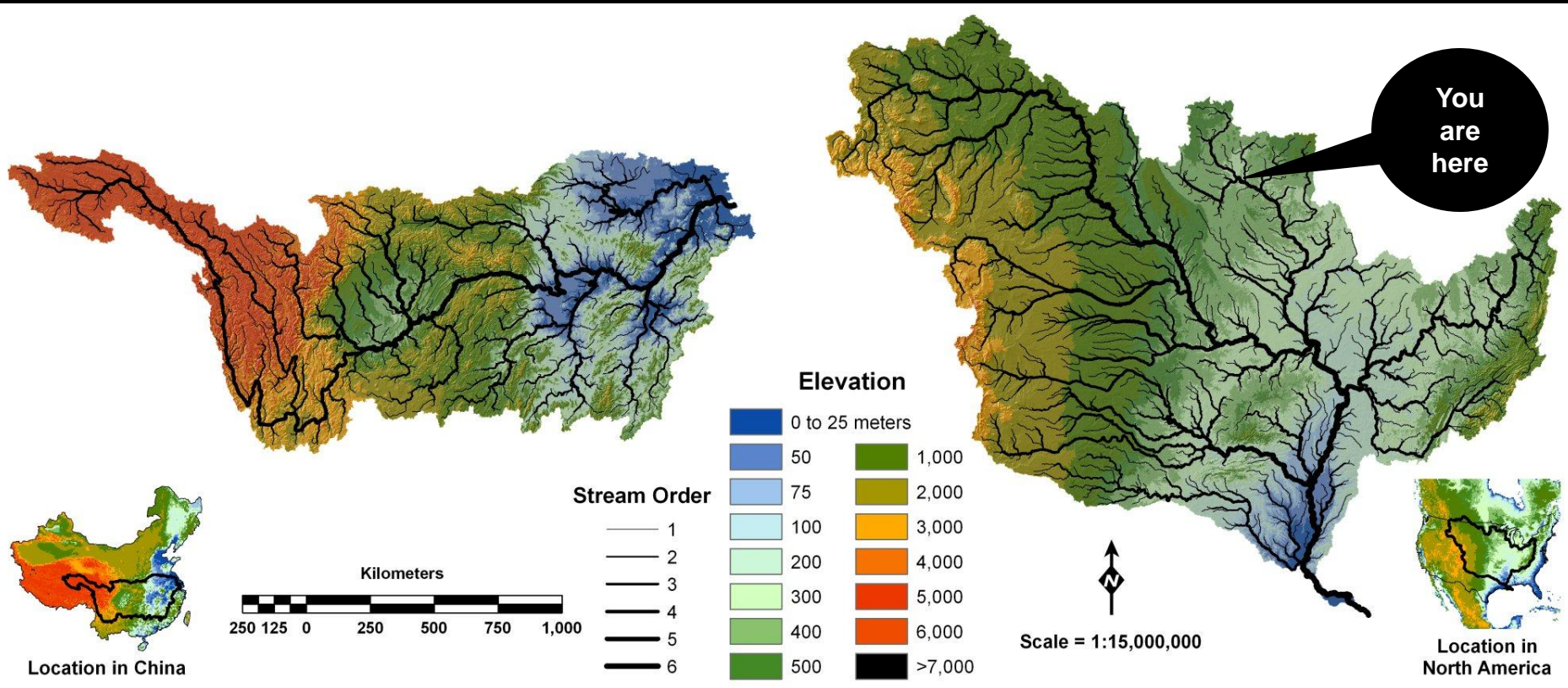
Discharge

MISSISSIPPI

3,202,000 km²

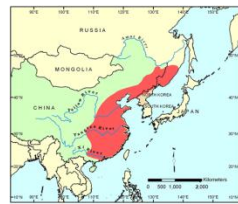
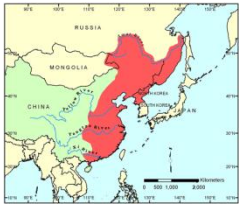
3,703 km

17,545 m³/s

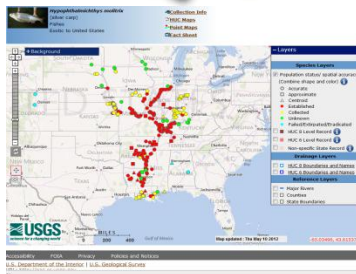


Source: USGS, Upper Midwest Environmental Sciences Center, 2008

The Four Famous Chinese Carp



Native range maps not available, but similar to silver and bighead carp



[North American Distribution Maps Above are Current as of 10 May 2012, as cited]

Silver carp

- Planktivore
- Most cultured fish in the world
- 22degN distribution
- 500k- >2 m eggs
- Eggs semi-buoyant and drift
- Can attain 60+ pounds
- Leap up to 3 meters high

Bighead carp

- Planktivore
- Fifth most cultured fish in the world
- 24degN distribution
- 250k – >1.2 m eggs
- Eggs semi-buoyant and drift
- Can attain 80+ pounds

Black carp

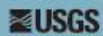
- Molluscivore
- Can attain > 100 pounds
- 15 deg N distribution
- Only a few individuals have been observed in the wild (triploid)
- Control, agent for snails in aquaculture

Grass carp

- Herbivore
- Used in pond management to control “weeds”, nationally since the 1960s
- Can attain 60+ pounds

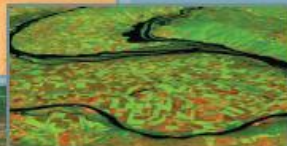
Illinois River, near Havana, IL; photo credit Nerissa Michaels, INHS, Havana, IL)





Long Term Resource Monitoring Program

Status and Trends of Selected Resources of the Upper Mississippi River System



“...The Mississippi River and its principal tributaries provide a highway for nonnative species to travel from areas as geographically disparate as the Atlantic Gulf Coast and the Laurentian Great Lakes to the interior of the North American continent.”...

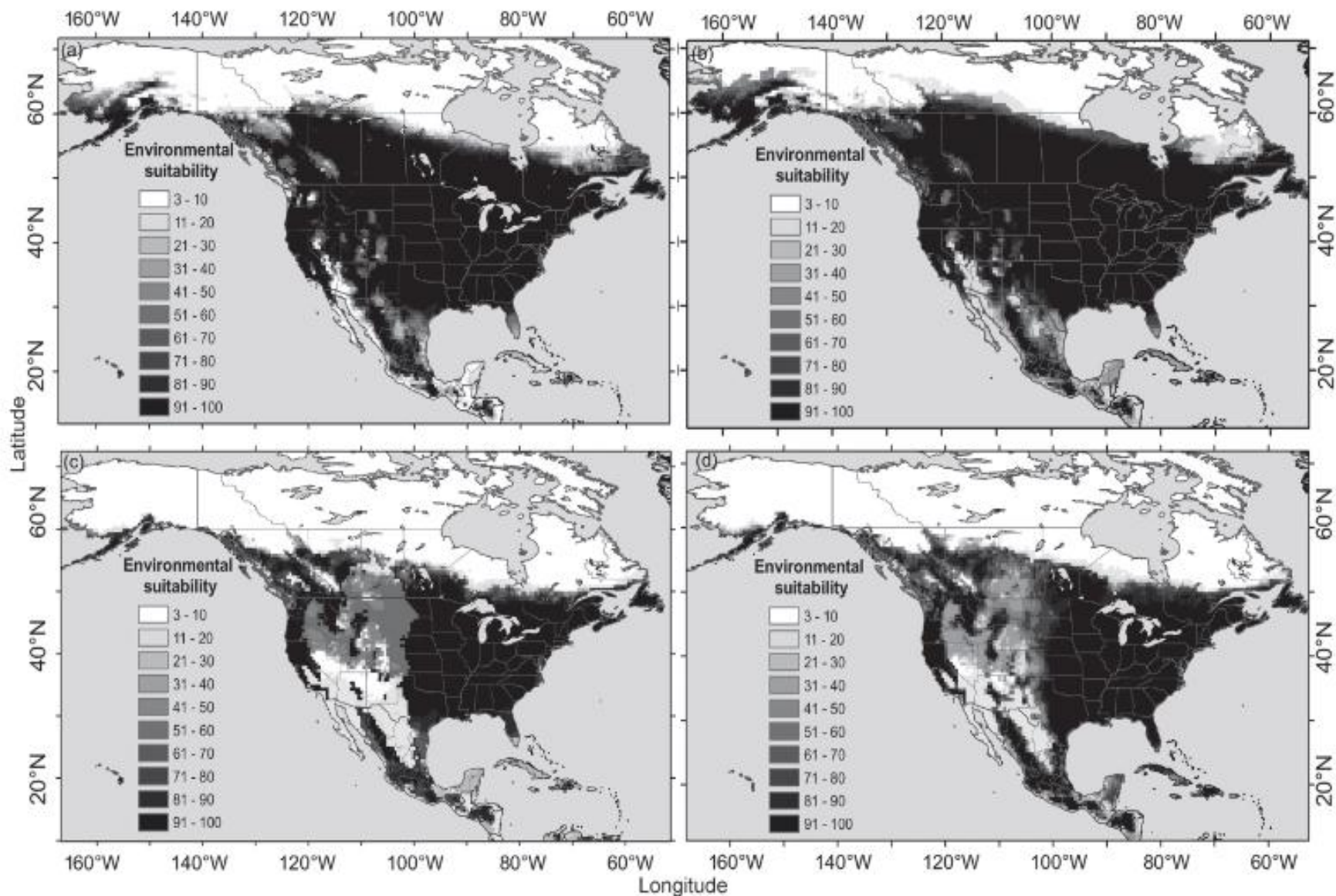
“...Recently established populations of silver and bighead carp in southern portions of the UMRS [sic, Upper Mississippi River System] are expected to increase in abundance...and advance their distribution within the UMRS.”

“...Because of the ability of many nonnative fish species to compete with and displace native species, nonnative species will remain a principal threat to native biodiversity in the foreseeable future in the Mississippi drainage, home to nearly one-third of the entire North American freshwater fish fauna.”

(2008) Page 75

available at: <http://pubs.usgs.gov/mis/LTRMP2008-T002/>

Fig. 2. Predicted suitable environment for four species of Asian carp (Cyprinidae) in North America. Environmental suitability is represented as the number (out of a maximum of 100) of models that predicted a particular location as suitable. (a) Grass carp, (b) silver carp, (c) bighead carp, (d) black carp.





Act I

The Great Irony of the Leaping Dragon Fish

鱼跃龙门

Yúyuèlóngmén ("Those who try hard will be rewarded with unimaginable benefits, regardless of how humble their origins")

Full delegation following talks in Beijing at the Hydrology Bureau



Migrational barriers



Exploitation



Commercial – 250,000 tons (avg 1949-2000, peaked in 1954)

- 63% from Lower, 34% from Middle, 3% Upper

Recreational – Not managed, not significant

Fry take for farms – extensive aquaculture relies on relocating fry from the river to grow-out in isolated floodplain lakes



Exploitation



Trap and pound nets within an oxbow lake on the Yangtze Floodplain near Jianli County, People's Republic of China, May 2011

Dredging





Pollution

Almost unimaginable levels of navigation and
industrial uses



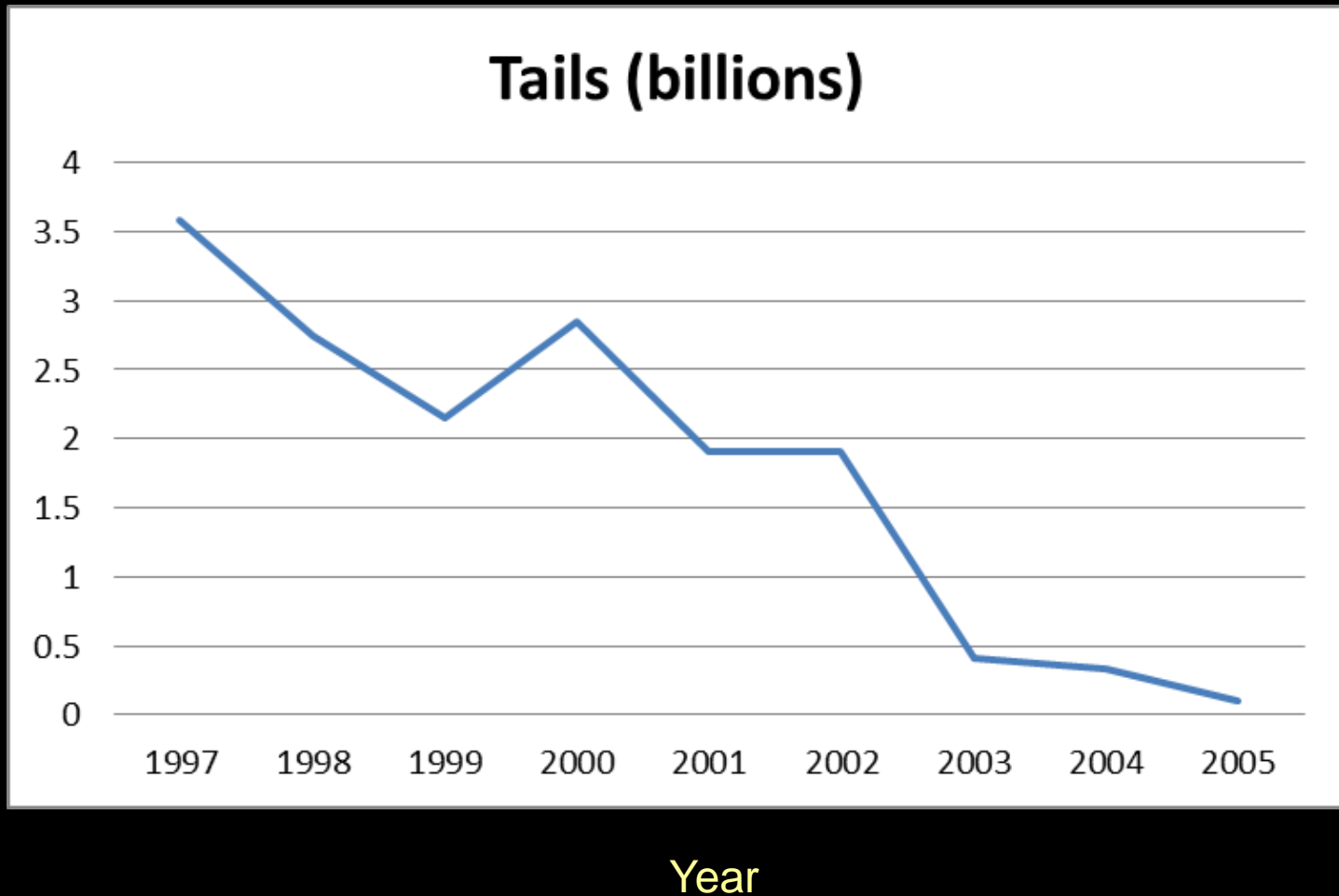






Trends in the egg and larval drift of the Four Famous Chinese Carps in the Yangtze (Changjiang) River, 1997 – 2005

Asian carp eggs and larvae (billions)





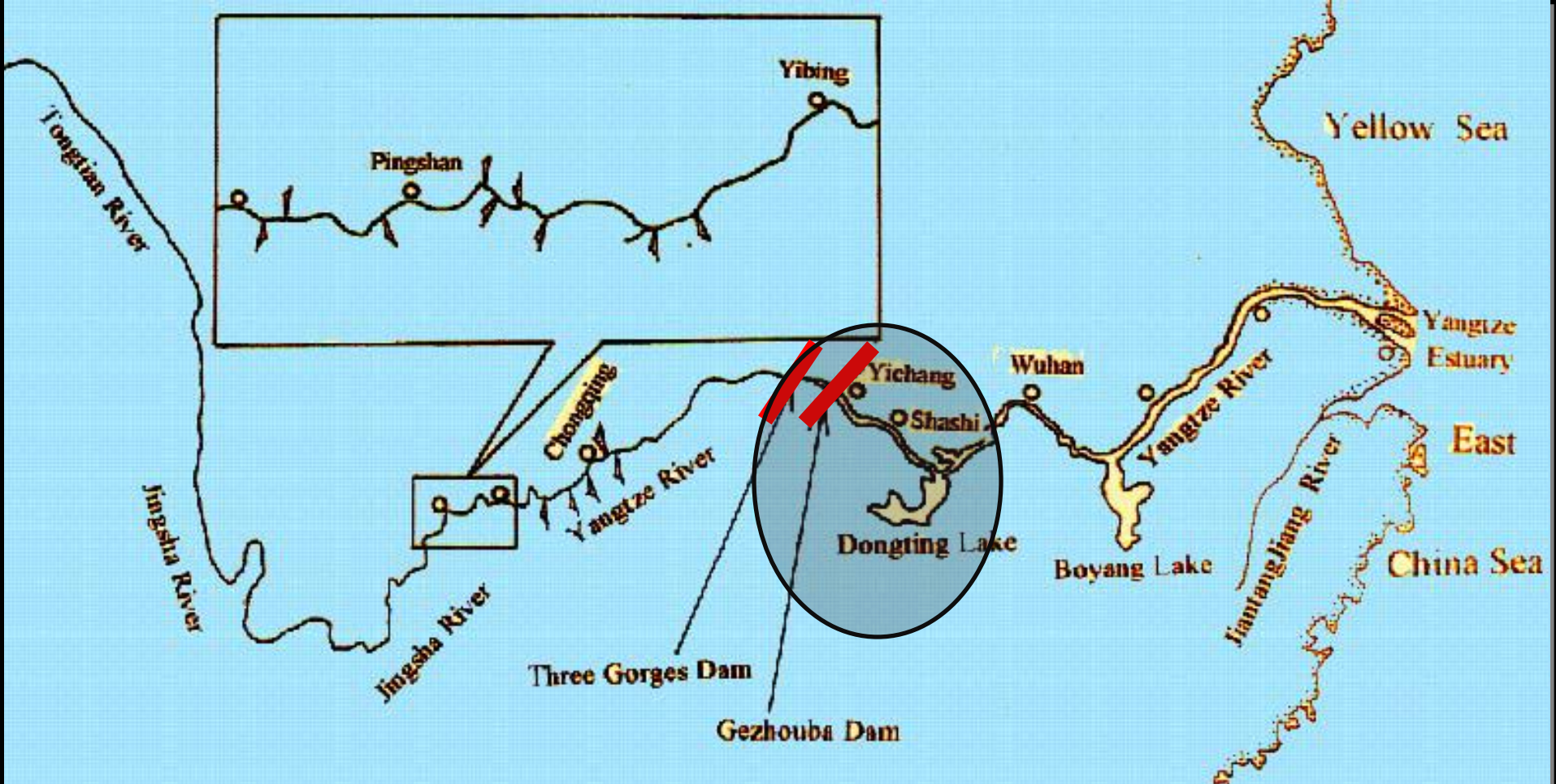
The science of it...

- What is contributing to the precipitous declines in Chinese Carp reproduction in the Yangtze basin?
 - Ho1: Altered flow regimes associated with Gezhouba and Three Gorges dams (E-flow)
 - Ho1a: Impaired migration cue hypothesis
 - Ho1b: Loss of spawning area hypothesis
 - Ho1c: Altered thermal environment hypothesis
 - Ho1d: Inhospitable changes for early life-stage survival hypothesis – flow and drift patterns modified
 - Ho2: Over-exploitation on spawning stock (recruitment overfished)
 - Ho3: Over-exploitation of larvae and lack of escapement from extensive aquaculture
 - Ho4: Water pollution or otherwise altered ecological function associated with pollution and dams

.....

There are many basic questions, limited means to address them, and countless applied implications that will result from investigations into all of these topics, and more...





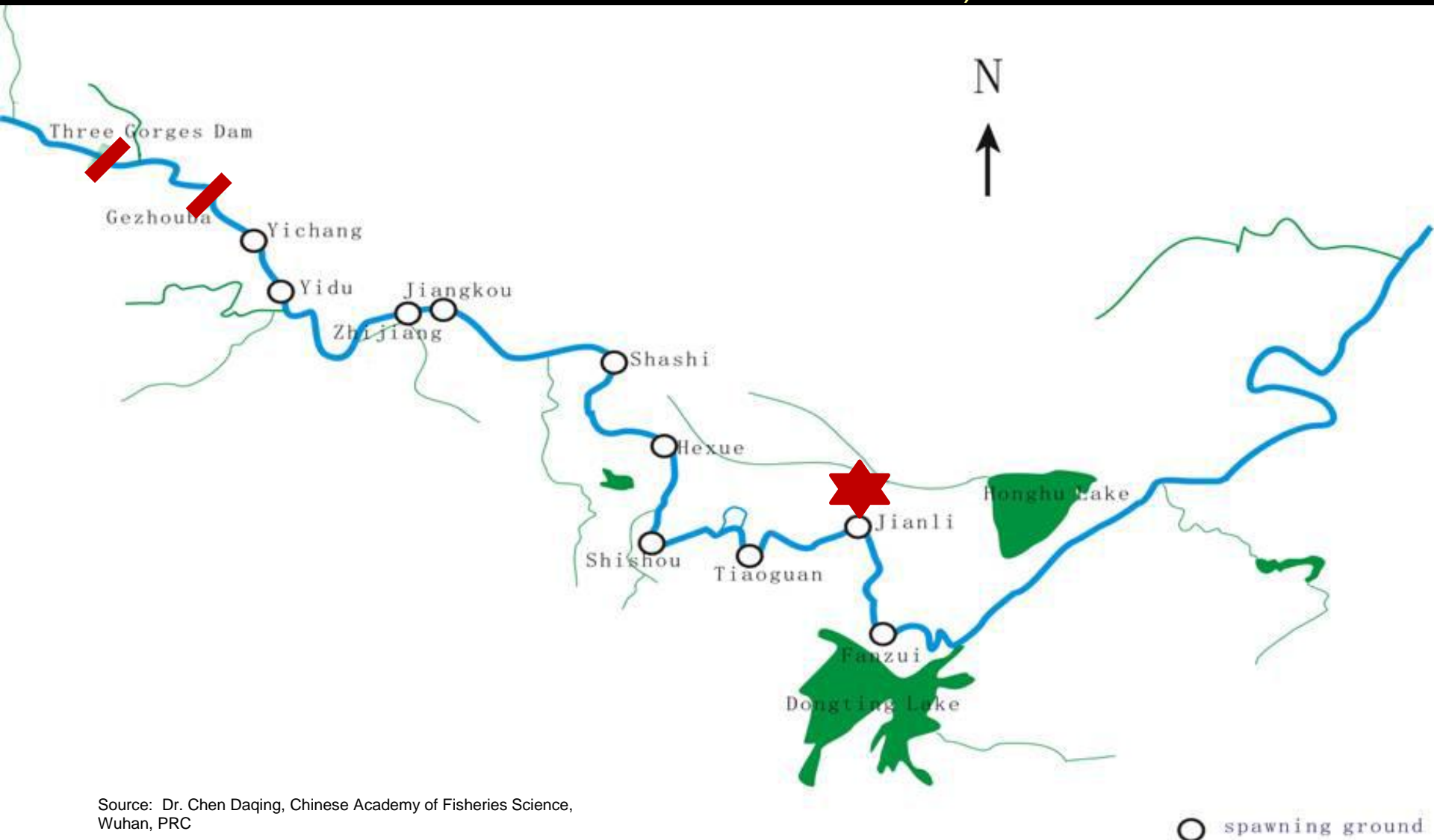
Dongting and Boyang (Poyang) Lakes are crucial habitat for Chinese carps in China

Dongting (2800 – 20,000 sq km) Poyang (1000 – 4400 sq km; now 200 sq km)

Comparison: Mille Lacs = 520 sq km; Lake Erie = 26,000 sq km

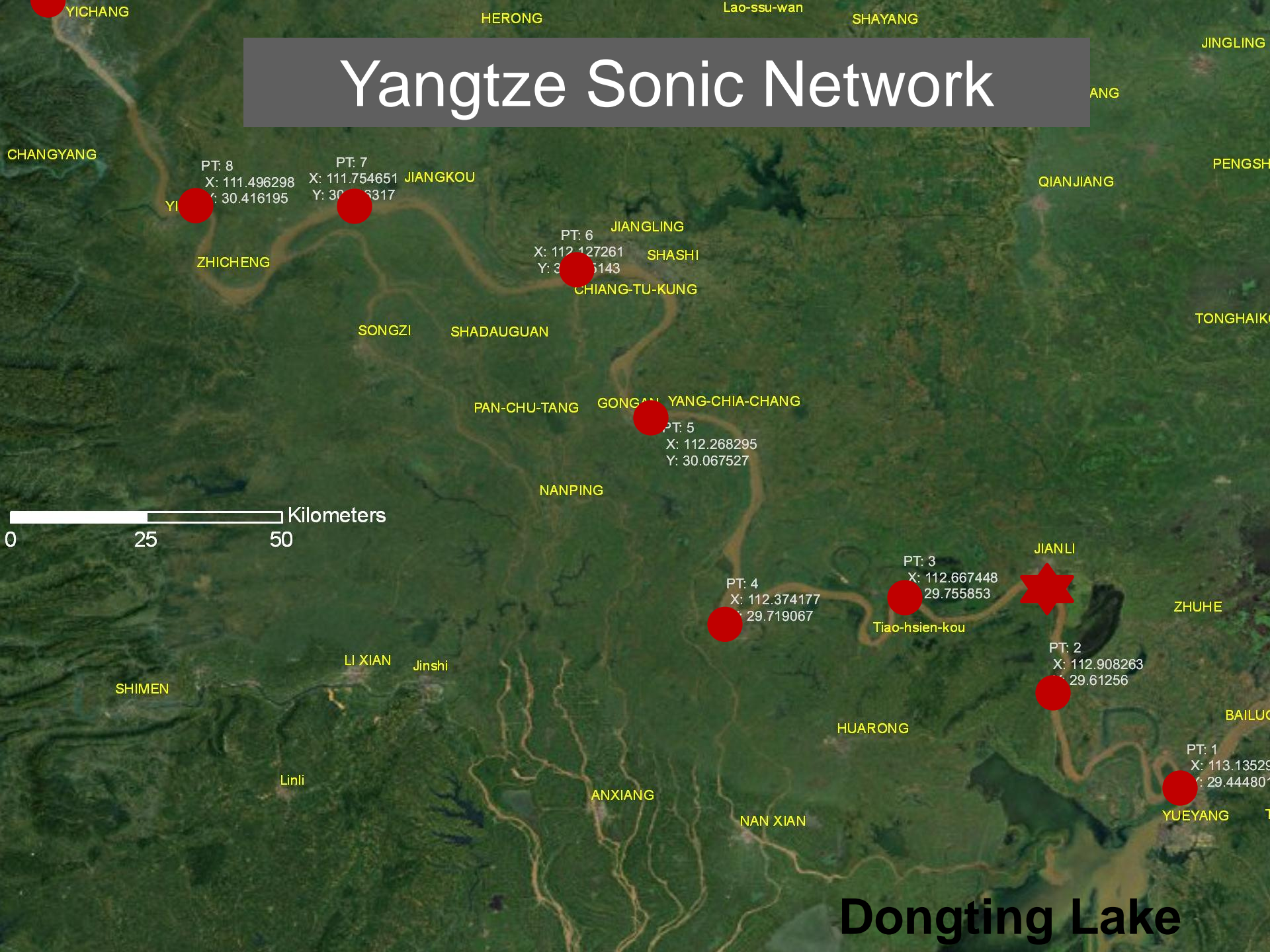


Historical spawning grounds for the Four Famous Chinese Carp in the Yangtze (Changjiang) River (and site of the Sonic Receiver Network installed in 2010-2011)

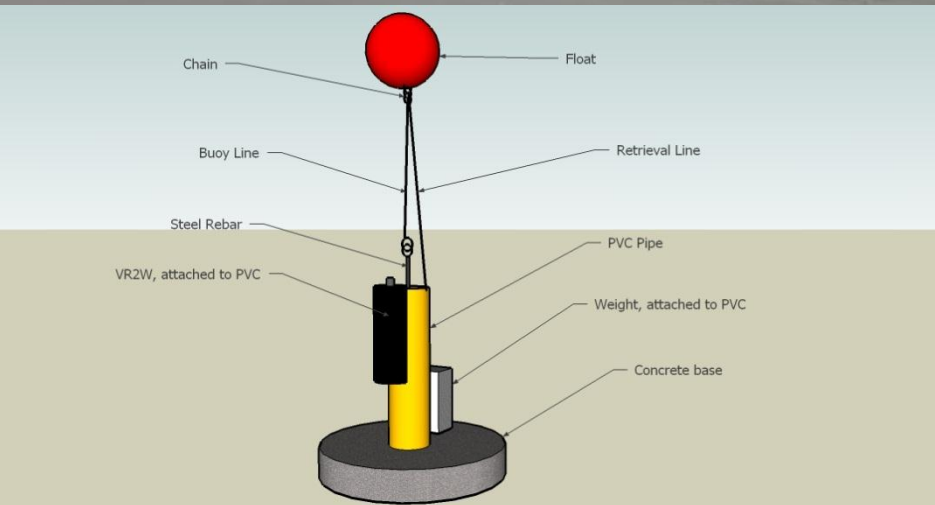


Source: Dr. Chen Daqing, Chinese Academy of Fisheries Science, Wuhan, PRC

Yangtze Sonic Network



Dongting Lake







The Great Irony of the Leaping Dragon Fish

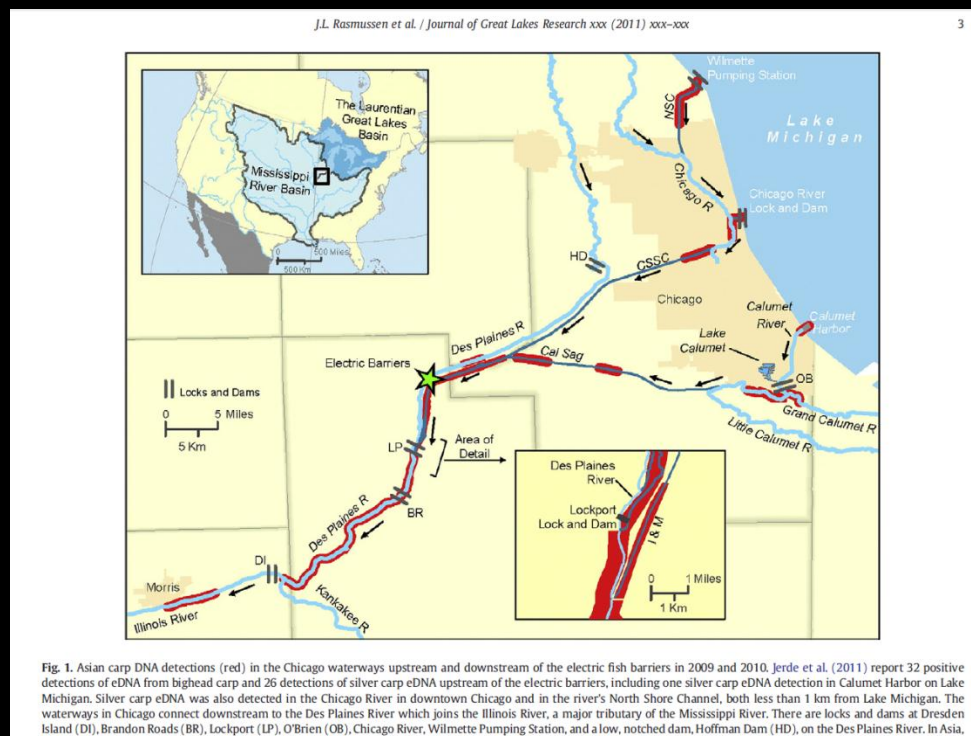
- The “Leaping Dragon fish”, a cultural symbol of bravery, perseverance, and strength, is (a) increasingly endangered in the wild; and (b) perhaps the most “domesticated” animal on the planet (Silver Carp is the most cultured fish in the world and Bighead Carp is the fifth [FAO]).
- Still, the “Leaping Dragon fish” has earned its reputation by leaping across the planet to new waters in the US. My colleagues in China describe the silver carp as “brave and strong - capable of achieving great things”.
- While revered in its homeland, it is largely regarded as a pariah in its “newest home”.
- Perhaps the greatest irony here is this: As far as wild populations go, the greatest density of Asian carp on the planet now likely exists in Illinois waters of the Illinois and Mississippi Rivers – places largely inhospitable to aquatic life a mere 60 years ago as we began recovery from our industrialization phase...



See “IckesSilverCarpVideo Slide32.wmv” file for video

Act II: When the things that connect us are the things that divide us...

A little broader perspective on the problem of aquatic invasive species in the Great Lakes and Mississippi drainages...



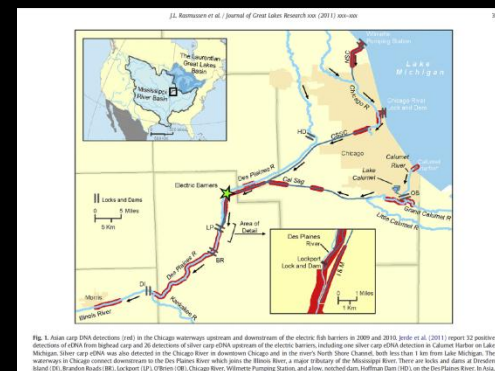
The great irony here, of course, is this...

We are trying to keep invasive Chinese carps out of the Great Lakes, to protect an invasive (yet purposefully stocked) Pacific salmon fishery, which was stocked as a management tool to control hyper-abundant alewives, another invasive fish species, because the native piscivore, the Lake Trout, was nearly wiped out by another invasive species, the sea lamprey, because people built the Welland Canal around Niagara Falls to promote intercontinental shipping deep into the Great Lakes basin.

A shipping canal started the sequence in 1939 with the completion of the Second Welland Canal, connecting the Eastern Atlantic to the interior Great Lakes. Similarly, the Cal-Sag Sanitary and Shipping Canal connects the Great Lakes to the interior of the North American continent and even the Gulf Coast.

[P.S. I'm pretty sure this is NOT what Aldo Leopold envisioned when he invoked the concept of "Round River"]

No one is really asking the questions about the impacts within the Mississippi River itself – it's been largely regarded as "a highway by which invasion occurs and threatens inland resources". Yet the Mississippi represents the richest freshwater fish fauna at temperate latitudes on the planet.



Grandma always said
“An ounce of
prevention is worth a
pound of cure”



Act III: What do we know, and how do we know it?

We know rather little really.

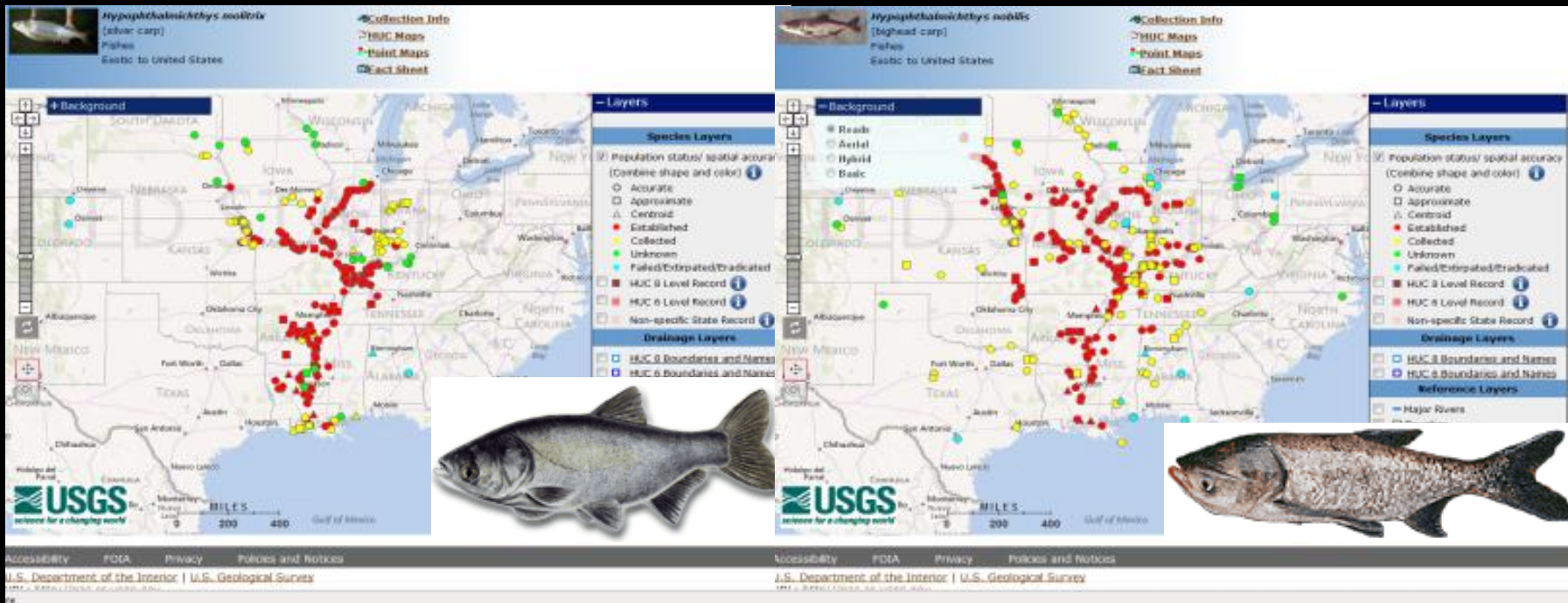
Far more questions than answers (or time)...

But, we also have some data sources to work with, and some experience in the southern reaches of the Upper Mississippi River, Illinois River, and Missouri River.

For example...

What do we know, and how do we know it?

Where is the invasion front?

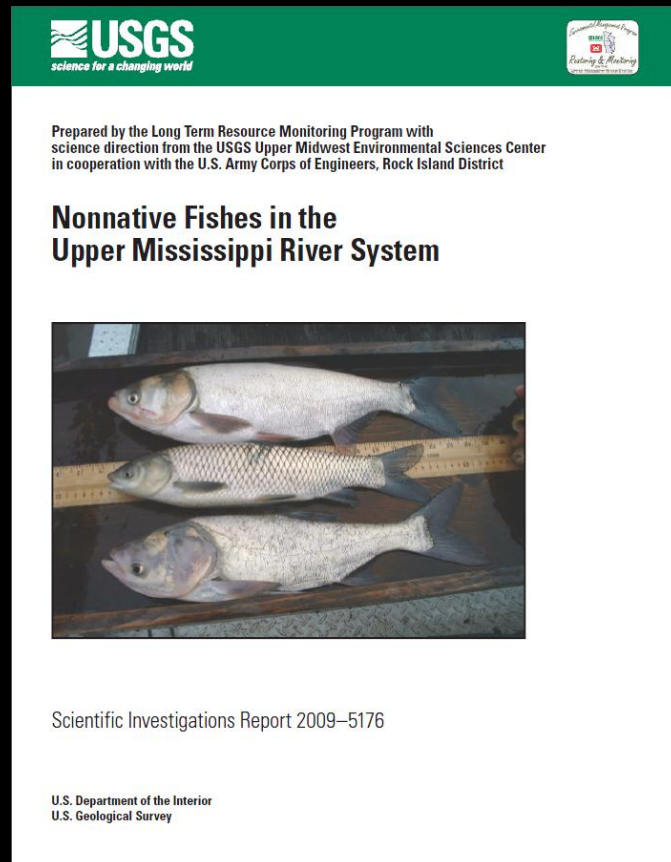


Where is the invasion front?



What do we know, and how do we know it?

What are the environmental associations of these fishes, which native species co-occur most frequently with them, which sampling methods seem most effective for sampling them, etc...



For all nonnative fishes in the UMRS...

- Native range biology
- Pathway of introduction
- Distribution in LTRMP study reaches
- Relation to habitat
- Catch by sampling method
- Trends in distribution and abundance
- Ecological impacts
- Discussion

Kevin S. Irons, Steven A. DeLain, Eric Gittinger, Brian S. Ickes, Cindy S. Kolar, David Ostendorf, Eric N. Ratcliff, and Amy J. Benson

Available at: <http://pubs.usgs.gov/sir/2009/5176/>

What do we know, and how do we know it?

When / where will they establish in MN?

Grass carp are established and likely have been for decades.

Silver and bighead carp: Require about 61 kJ/day [255 micrograms/L of macrozooplankton (dried) or 10.43 microgram/L Chlorophyll a (phytoplankton)] to grow at 20 degrees Celsius. [Cooke and Hill (2010) Freshwater Biology 55(10): 2138-2152]

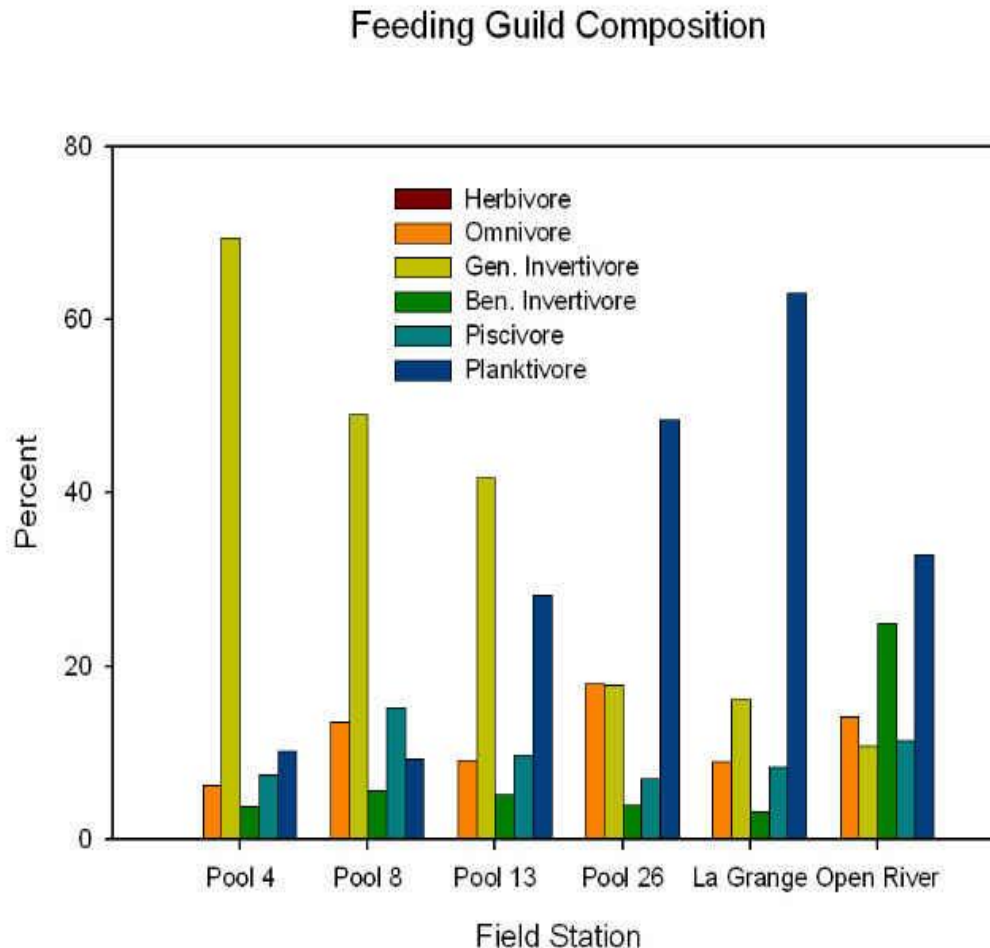
Some grad student could be using data such as this as part of a risk assessment for all inland and Mississippi River waters in MN.

Earlier work in China suggested eggs rupture easily in soft water (good for you in MN), but follow up work on the Missouri River (D. Chapman and J. Rach, USGS Columbia, MO and La Crosse, WI) showed eggs were more resilient than previously reported (bad for you MN).

Point is, many things we think we know from Asia and elsewhere end up being different here (either wrong or partially wrong in Asia reports, or more likely, fish are adaptable)

What do we know, and how do we know it?

What might be their ecological impact?



Data

UMRR-EMP-LTRMP
Fish Component data
1993-2004 (largely pre-
Asian carp)

3.8 million fish
observations, 138 species

Categorized by feeding
guild

No difference in functional
template over 1200 miles
of river

Substantial counter
gradients in abundance /
mass N→S

Zooplanktivory minor in N,
dominant in S

Alternative food web
pathways?

What do we know, and how do we know it?

What might be their ecological impact?

Recent field observations and experimental *in situ* contrasts in IL and MO are:

- (1) Revealing early impacts on other native zooplanktivores [Irons et al. 2007 Journal of Fish Biology (2007) 71 (Supplement D), pp.258-273]

Measurable declines in the condition factor (weight per unit length) in gizzard shad and bigmouth buffalo

- (2) Lipids and essential fatty acids (ω 3s and ω 6s) are reduced in native planktivores (gizzard shad, bigmouth buffalo and paddlefish) in the presence of Asian carp as compared to in their absence (Gutrueter et al. 2011, USGS Report).

The native planktivores are skinnier and more lacking in essential life sustaining compounds

The ecological consequences of these observations remain uncertain (is there a consequence to having “skinny fish”?)

What do we know, and how do we know it?

What might be their ecological impact?

Source data

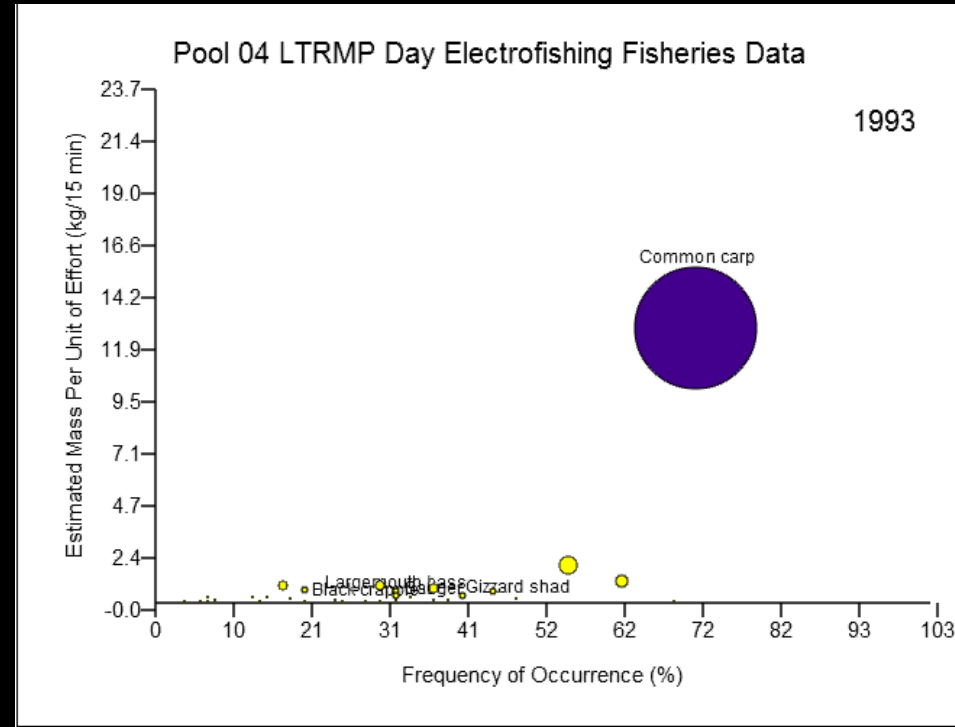
UMRR-EMP LTRMP

Frequency Occurrence x Mass Per Unit Effort

La Grange Pool, Illinois River and Pool 4 Mississippi River, for select species...

- **2 native zooplanktivores** (gizzard shad and bigmouth buffalo),
- **3 nonnatives** (common carp, silver carp, and bighead carp), and
- **3 select game species** (sauger, black crappie, largemouth bass)

[Bubbles are scaled proportionally by species mass to total fish mass]



See "IckesPool4Data Slide43.avi"
file for animation of graph

What do we know, and how do we know it?

What might be their ecological impact?

Source data

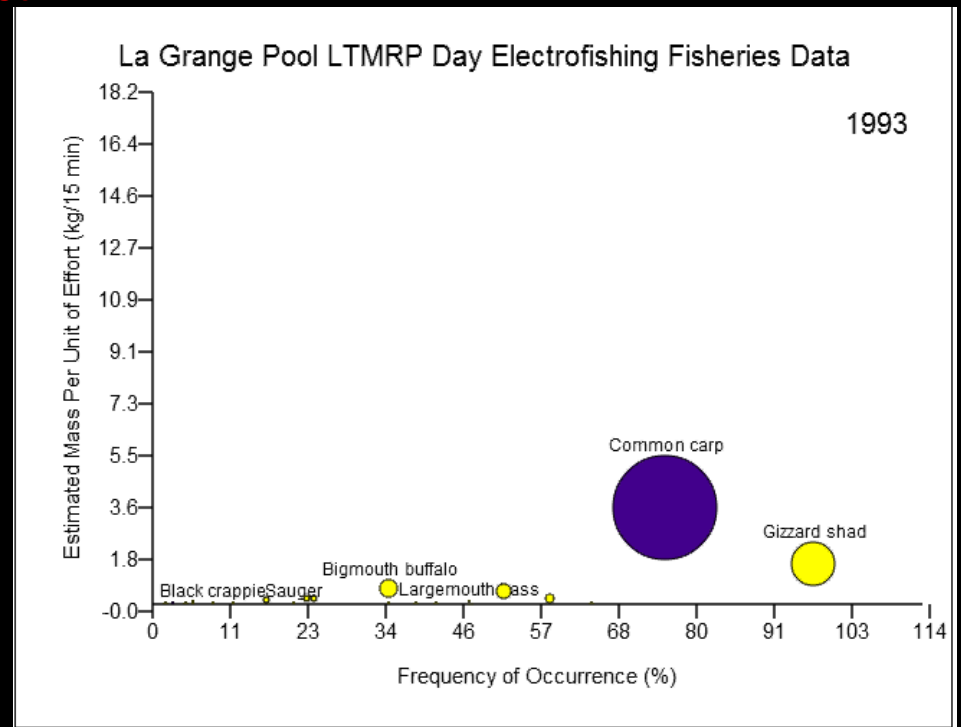
UMRR-EMP LTRMP

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[Bubbles are scaled proportionally by species mass to total fish mass]



See "IckesLaGrangeData Slide44.avi" file for animation of graph

What do we know, and how do we know it?

Can commercial fisheries control these species?

Commercial fisheries are small in the UMRS

Economic (and perhaps legal) barriers to entry and operation

- likely requires government subsidization/incentivisation to ramp up
- on going experiment in the Illinois River (Dr. Jim Garvey SIUC)

At densities experienced in the Illinois River, and based on population dynamics models, it seems that commercial fisheries alone cannot control them

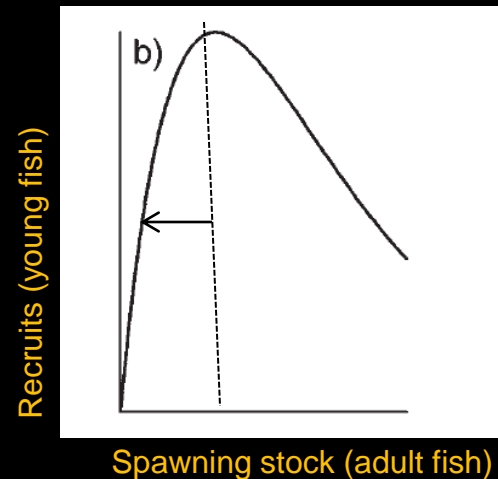
see Chapter 12, CARP 2011, Garvey et al.

- Assumes fishery focuses on fish > 500mm (~21 in.)

Effort would need directed at all sizes

Would lead to substantial conflicts with native fish bycatch

You'd need to be VERY smart in how you implemented this



What's working for you?

- Mississippi still has all native species – it has absorbed all past assaults – resilient
- Nav dams act as partial barriers, and some can be managed to be complete barriers
- Much experience being gained in IL, MO – use and learn from this
- The Mississippi is “healthier” in the north, and thus perhaps more resistant
- Within the Mississippi, the north has a much more abundant and diverse predator community
- Some emerging evidence from long term assessment programs suggest alternative productivity pathways that may be unfavorable for Asian carp in the northern reaches of the UMRS (but not necessarily so for inland resources)
- MN has phenomenal scientists, universities, and managers – invest in them and be kind to them, this is not their fault...
- Our society has invested in systemic monitoring and science w/in the invasion basin – use this asset and information

What's working against you?

- Unknown and presently unknowable potential impacts on inland fisheries – less resilient?
- MN is clearly at risk given the estimated and expected ultimate distribution of these species based on species biology, physiology, life history...
- MN has substantial resource uses likely to be adversely impacted if these species become established and abundant
- MN has poorly developed commercial/industrial fisheries that could be enlisted in a control effort
- There is no “silver bullet” yet (nor is there likely to be in the near future, if ever)
- Most partial remedies are either expensive, controversial, or both
- Integrated pest management remedies will take time and significant investments to develop, test, and deploy

Closing thoughts

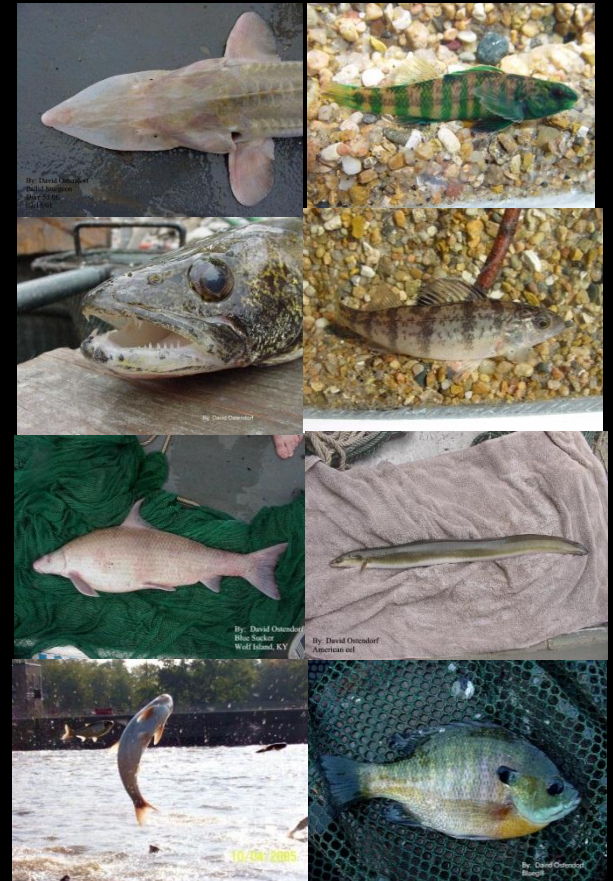
There is value and utility in comparing great rivers, engaging cultures as you do so, and gaining insights into great problems

Because of work in China, we have just recently secured cell lines for Asian carps to use in rapid screening trials as we investigate potential chemical controls. Also, E-DNA methods, developed here in the US, are likely to be used in the upper reaches of the Yangtze and Yellow Rivers to determine the persistence of rare endemic species.

Think beyond your borders, your mandates, your comfort zones and the immediate demands of the day

What are the likely impacts on the greater biodiversity of the Mississippi and Illinois Rivers?

Forge partnerships – our problems are large, multijurisdictional, and even international. Our solutions should be likewise (perhaps?)





水是宝贵的

我们很感谢您的节省

WATER IS PRECIOUS